

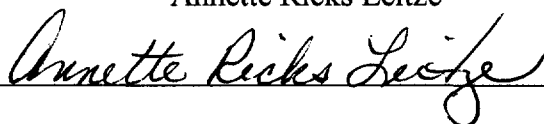
Standard Math Education:  
*An Examination of 4<sup>th</sup> Graders' Computational and Problem-Solving Skills*

An Honors Thesis (HONRS 499)

by

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A handwritten signature in cursive script, reading "Annette Ricks Leitze", is written over a horizontal line.

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## **Abstract**

This study examined the effectiveness of standards based education in elementary school mathematics. The investigation focused on fourth graders' computational and problem-solving skills during the fall semester in an Indianapolis Public School. The data for this examination were collected from three sources. A pre and posttest was given to each student and daily observations were made throughout the semester. The tests were identical and were modeled after the standards delineated by the Indiana Department of Education, with one question for each substandard. The pretest was given within the first two weeks of the semester and the posttest was administered at the end of the term. These data were evaluated to measure development during the semester. Progress of students toward mastery of the standards was significant in many areas, while some standards were not mastered at all. Progression was greater for the computational standards than for the problem-solving standards. This study provided proof of the prevalence and importance of standards in elementary mathematics, whether or not they are directly instructed upon. Standards based education may not be the perfect curriculum foundation, but it remains the best possible alternative at this point.

## **Acknowledgements**

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Many thanks also to the principal and teacher with whom I worked in the Indianapolis Public School. They opened their school and classroom to me and offered encouragement and support that was invaluable. Without the support of these professionals, this investigation would not have been such a success. Thank you for your willingness to support this classroom investigation.

## **Introduction**

This investigation was designed to explore the effectiveness of standards based education in elementary school mathematics. Standards based education is the current trend in the American educational arena. Standards based education is a major emphasis of the teaching curriculum at Ball State and other education programs across the country. I wanted to gain a sense of the actual use of the standards in an Indiana classroom. In order to gain a better understanding of why these standards are important, I also conducted research on the history of this current trend of standards for all content areas.

### **Standards Movement**

“Many, if not most, educators are unaware of the impact the very discussion of standards has had on American education, let alone the reorganization of schools around standards” (Marzano & Kendall, 2001, p. 1). The standards movement in education is a modern phenomenon, but standards are not a new thing to education. There are documented measurements of educational effectiveness in Boston as early as 1845. The modern standards movement is most commonly attributed to the publication of the now famous report, *A Nation At Risk*, by the National Commission on Excellence in Education (NCEE) in 1983. The now notorious report brought education to the public arena and made it a political issue. Former Assistant Secretary of Education Diane Ravitch is regarded as one of the chief initiators of the modern standards movement. According to Ravitch (1995), standards can improve student achievement by identifying instructional content and performance expectations. The publication of *A Nation At Risk* by the NCEE brought about growing concerns about the education of our nation’s youth and made a very harsh dictation.

— The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur--others are matching and surpassing our educational attainments. If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves. We have even squandered the gains in student achievement made in the wake of the Sputnik challenge. Moreover, we have dismantled essential support systems which helped make those gains possible. We have, in effect, been committing an act of unthinking, unilateral educational disarmament. (NCEE, 1983, p. 5)

— These concerns led to an Education Summit in Charlottesville, Virginia in 1989. President George Bush, along with the nation's governors, formulated six broad goals for education to be achieved by the year 2000. Included in these goals is one that speaks directly to mathematics standards. Goal 4 states that by the year 2000, mathematical and science achievement by U.S. students will be number one in the world (National Education Goals Panel, 1991). Following this summit, national subject matter organizations such as the National Council of Teachers of Mathematics (NCTM) began to establish standards in their respective areas. The NCTM published its *Curriculum and Evaluation Standards for School Mathematics* in 1989, leading the way in the modern standards movement. In this document, the NCTM identified three historical reasons—quality control, goal indication, and promotion of change—for the adoption of standards (NCTM, 1989). Since 1989, many other education organizations have developed

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standards for their respective areas, and the states have used these standards as models for statewide assessments and standards. The NCTM went on to develop other standards documents since 1989. In 2000, NCTM published its *Principles and Standards for School Mathematics* as part of its project, “Standards 2000,” which was designed to update and revise their original standards documents. The organization gives the following rationale for its “Standards 2000” project and the document it produced.

*Principles and Standards for School Mathematics* is intended to be a resource and guide for all who make decisions that affect the mathematics education of all students in prekindergarten through grade 12. The recommendations in it are grounded in the belief that all students should learn important mathematical concepts and processes with understanding. (NCTM, 2000, p. ix)

Standards have permeated the disciplines and school systems throughout America’s educational system since the summit in 1989. Most states have now adopted a standards base for their curriculum in at least one of the disciplines. According to Hadderman (2000), Iowa is the only state that has yet to adopt K-12 content standards.

### **Investigation Purpose**

Holding public education to high standards is popular, especially since politicians like standards and the tests that measure their attainment. There have also been public opinion polls that show that the public approves of high standards in school. The push for standards based education in American schools has led to an emphasis on teaching the standards in university education programs. Ball State University is no different, as all education classes I have taken have maintained an emphasis on applying the standards in every lesson planned and executed. This led me to the question I wanted to investigate in

— this study. With all the emphasis on the standards in education and teaching programs, I wanted to investigate the actual learning and ability levels of students based on the standards. I chose to investigate the mathematics standards because of the increasing emphasis on mathematics mastery for all students in the American education system. “The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase” (NCTM, 2000, p. 4).

— Among mathematics skills that are in dire need in the United States, in my opinion, are computational and problem-solving skills. For this reason, I chose to investigate the mastery of standards set forth for computational and problem-solving skills in Indiana. These standards are based on the standards published by the National Council of Teachers of Mathematics, so they contain national substantiation as well. The Indiana academic mathematics standards are set forth to guide the development of students’ mathematics skills in Indiana classrooms. These standards need to be learned in order for students to continue to advance during their academic careers. The data collected in this study will provide insight into the actual level of mastery of computational and problem-solving standards skills over the course of one semester. This insight is important to give substantiation to the emphasis on the standards based education in the classroom. The question I posed and tried to answer in this study was, *What is the actual level of mastery and development of fourth grade students’ computational and problem-solving skills according to the standards set forth by the Indiana Department of Education?*

## **Methodology**

This investigation of fourth graders' computational and problem-solving skills was set up as a noninvasive research project intended to yield results in a normal classroom. The study was done mostly on an observational and objective basis. The study was designed to offer a glimpse into the normal instruction that occurs in a fourth grade classroom to determine the applicability, implementation and mastery of the standards. In order to accomplish this goal, observation and objective analysis of students' performance in the everyday course of classroom activity was the prime directive of the study. Several steps were taken to ensure the success of the study, as well as to maintain the confidentiality of the subjects involved. These steps included Informed Consent Forms, pre and poststudy tests, daily observations and notations, and analysis of the tests and observation data.

### **Population**

The subjects in this study consisted of sixteen fourth grade students in an urban school. The school was an Indianapolis Public School on the northeast side of Indianapolis with a large African American population, of which approximately 81% of the students received free or reduced meal rates. The particular subjects of the research project were split evenly in terms of gender, with eight males and eight females participating. All of the subjects ranged in age from nine to ten years old, and were a part of a classroom taught by a young African American female professional educator. The cultural or ethnic breakdown of the population involved in this study consisted of thirteen African American students, two Hispanic students, and one Caucasian student. All



students freely participated and were included based on informed consent from both student and parent to be a part of the research investigation.

### **Informed Consent**

Before beginning the investigation of the skills of the fourth graders in the classroom, I had to make sure that the students were informed of the investigation, and that they gave their consent to participate. The Institutional Review Board of Ball State University, and the Department of Research, Evaluation, and Assessment of the Indianapolis Public Schools require that the subjects of the investigation return a signed Informed Consent Form acknowledging their willingness to participate. Since the subjects of the investigation were fourth graders, ranging in age from nine to ten years old, their legal guardians also had to be informed and give their consent. In order to facilitate this requirement, I drafted an informed consent form that was sent home with each student prior to beginning the investigation. This form included all the information concerning the requirements of the study, risks to the students, benefits of the study to the students and the community, voluntary participation in the study, and the integrity of the study. The parents and students were required to complete a consent statement as well as sign the form in order to be included in this investigation. The consent forms were then filed and kept in order to ensure the integrity of the investigation. See Appendix A for a copy of the Informed Consent Form.

### **Instruments**

One of the integral instruments in the study was a pre and posttest. These tests were identical, and a copy can be referenced in Appendix B. The first part of the study involved a pretest. This test consisted of 22 questions incorporating the math standards

the study was designed to investigate. Each question corresponded to a specific substandard of the two Indiana mathematics standards I was investigating. These questions were modeled after the questions and suggestions that the standards themselves lay out. This test was given to gauge the comprehension and mastery level of the fourth grade standards for this group of students prior to the fall semester. I administered the pretest during the second week of the fall semester in order to gather the baseline data. It also served as a basis for comparison with the same test given at the end of the semester to analyze accomplishment and progression throughout the semester. On one of the final days of the semester, I gave the same test to all of the students participating in the investigation. The test was never altered and copies of it were available upon request for review. Students were encouraged to do their best, while skipping anything they found frustrating or incomprehensible. I stressed the fact that the results of the test would not affect their grade or anything in their school environment so that the students would not be forced to guess. I was more interested in the actual knowledge base and mastery that the students had for the standards, than their ability to take a test or guess in order to appear like they knew the answers. I used data from the pre and posttests to help analyze the students' knowledge and mastery of the standards.

### **Observations**

Along with gathering the pre and posttests to analyze the progression of students' knowledge over the course of the semester, I made daily observations of the students in the classroom. Mathematics instruction occurred every day in the classroom schedule, making it easy to observe the learning in which the students were engaged. A data sheet was kept on hand at all times to observe the students' progress towards mastery of the

standards. A copy of this data sheet can be referenced in Appendix C. A copy of the standards themselves was also kept on hand at all times for reference when observing behaviors and student performance. A copy of these standards is available for reference in Appendix D. During mathematics instruction in the classroom, I observed the students and made marks based on what standard I saw the student exhibiting mastery of or progression toward. Along with the noted marks, comments were also made at the bottom of the sheet to further document circumstances and other important things to consider during observations. This method was chosen to ensure the genuine results that I designed this project to return.

### **Evaluation**

The methods for evaluating the data were quite simple and straightforward. The two tests were compared for the population to evaluate progress throughout the course of the semester. Along with the comparison of the tests, the observation records from throughout the semester also served to assist in the analysis. The final part of the analysis was my subjective evaluation of the students' abilities, progression, and mastery of the standards. These methods allowed the data to be analyzed to determine the level of mastery of the standards by the students involved in the investigation.

All of the methods involved in this study were set up to promote the success of the investigation and gather data without interrupting the every day classroom activities. The true purpose of the study was to analyze the progression and mastery of the standards in a normal classroom setting to determine the true effect of these standards. All of the methods involved—the consent forms, pre and posttests, daily observations and

notations, and analysis of the tests and observation data—were set up and carried out according to guidelines by all organizations with interest in the investigation.

## **Data Analysis**

I collected data for this project to explore the actual mastery of two Indiana standards for mathematics in a fourth grade classroom. I collected the data using pre and posttests that gauged the mastery of the selected standards I was measuring, and daily observations of student progress. The pre and posttests were analyzed based on completion of the problems and also the problems that received no responses. Students were encouraged on both tests to skip anything they were not capable of doing, so problems that did not foster responses were taken into consideration during the analysis of the data. The daily observations were notes that I took over the course of the semester when I observed the standards being applied or mastered. This section is the result of the analysis and evaluation of all data collected. I have organized the information by mathematical standard and substandard in order to present an explanation of each of the 22 substandards this project focused on under the computational and problem-solving standards. A copy of the standards discussed in this section can be found in Appendix D, and a copy of the pre and posttest problems can be found in Appendix B.

### **Computation Standard**

#### **Indiana Mathematical Standard 4.2 *Computation.***

***❖ Students solve problems involving addition, subtraction, multiplication, and division of whole numbers and understand the relationships among these operations. They extend their use and understanding of whole numbers to the addition and subtraction of simple fractions and decimals.***

The computation standard is the first standard I examined in this investigation. There are twelve substandards listed under this standard in the Indiana Academic Standards. Each substandard had a corresponding question on the pre and posttests. I also kept each substandard with me during mathematics instruction in the classroom to

aid in my daily observations. Each substandard was evaluated individually for the population to gauge mastery and effectiveness, with the following results.

**Indiana Mathematical Standard 4.2.1.**

***Understand and use standard algorithms for addition and subtraction***

The corresponding question on the pre and posttests asked students to solve the addition and subtraction problems  $45,329 + 6,984$  and  $36,296 - 12,075$ . Of the 16 students who took the pretest, only four or 25% answered this question correctly. Five, or 31%, did not record any response or answer to this problem. There were two students who mixed up the operations for this exercise and did addition for both problems listed. On the posttest, of the thirteen students, six or 46% completed both problems successfully. There were only thirteen students who took the posttest because of circumstances beyond my control. This was unfortunate, because one of the students I was unable to retest was one of the stronger students in the class. Only one student, or eight percent of the population, failed to record a response on this exercise. Three students for this exercise answered half of the exercises correctly. These students made simple addition mistakes on this exercise.

Observations during the semester were made on two different occasions for this substandard. On October 17, 2002, I observed that the majority of the students in this study mastered a lesson that was taught on the basic properties of addition. This shows that the information was presented according to the standards, and that standards-based mathematical instruction was present on this occasion. The students who struggled with the properties-of-addition lesson turned out to be the same students who failed to complete this pre and posttest exercise correctly. On October 22, 2002 I observed that

the majority of these students were also able to demonstrate in class and on a homework assignment the ability to subtract three digit numbers with regrouping. These students were able to answer 90% of the questions asked on a homework assignment and in class. A sidenote to this observation however, is the fact that part of the observation consisted of performance on a homework assignment, so the amount of assistance from parents on this exercise is unknown. This combination of empirical data and informal observation gives me the idea that this skill that the standards sets forth for fourth grade mathematics, was introduced and instructed upon well enough to promote the success of students in the classroom.

#### **Indiana Mathematical Standard 4.2.2**

*Represent as multiplication any situation involving repeated addition*

The corresponding question on the pre and posttests stated that a woman makes five bracelets, and each bracelet has four beads. It then asks the students to find the total number of beads the woman used. Of the sixteen students who took the pretest, 11 students, or 69% percent completed it correctly. This was surprising because I was not aware that the students were familiar with exercises like this. On the pretest as well, only one student or six percent of the population failed to record a response. The posttest yielded similar results, with eight or 62% of the students responding correctly and all 13 students submitting a response. The student who failed to record a response on the pretest and two of the students who recorded correct answers on the pretest are the three students whom I was not able to retest, so I am not sure if these students would have adversely affected these data or not. It is very possible that the students whom I was unable to retest would have answered the posttest question correctly, bringing the

percentage closer to the pretest data. There were positive improvements for some of the students however, which leads me to believe that this topic was covered somewhat sufficiently during the semester.

During the semester, I also made a couple of observations for this substandard in addition to the pre and posttest data. Early in October, the fourth to be exact, there were problems involving repeated addition on a homework assignment on which I observed the students working. These problems were not labeled as multiplication, but they introduced and reinforced the practice of repeated addition, which helped lay the foundation for multiplication instruction to come later. Direct instruction of multiplication came later in the semester, in the beginning of December. On the second of December, multiplication was introduced as repeated addition, building on the students' previous experiences. According to my observations, students recognized that two times three written in the algorithmic form,  $2 \times 3$ , is the same as adding two groups of three together. There were other examples in the lesson that the majority of the class understood, and at least half of the subjects showed a distinct level of mastery for this concept. Another interesting observation deals with the pretest, in which several of the students used pictures to get the answer for the corresponding problem. This demonstrates concrete understanding early on, that did not show up later on the posttest because of the practice and instruction during the semester. This is a demonstration and empirical evidence that standards based education was occurring during the semester, whether or not all students mastered it.

**Indiana Mathematical Standard 4.2.3.**

*Represent as division any situation involving the sharing of objects or the number of groups of shared objects*



This substandard had the corresponding problem on the pre and posttests that asked if you have twenty cookies, how many would each student get if you divided them evenly among five students? On the pretest that all 16 students completed, nine students, or 56% of the population, answered the problem correctly, while two students, or 13%, failed to record a response at all. This was another surprising result for the pretest because I was under the assumption that division was not really introduced until the fourth grade. The posttest also showed positive results with nine of the 13 students, or 77% of the population, answering the question properly, and no students failing to answer. One of the students who failed to answer the exercise on the pretest was one of the students I was unable to retest, so I am not sure if that student's result would have affected the data positively or negatively.

Observations of this standard in action were not recorded during my time in the classroom. The students were working with multiplication and introducing division during the last weeks of the semester that I was there, but no corresponding activities had occurred for this standard as of yet. I am sure that the division standards were planned and implemented, but as of the end of this investigation, nothing had been done. This does not mean that standards were not part of the classroom, but it demonstrates to me the order and care with which they were handled to ensure mastery.

**Indiana Mathematical Standard 4.2.4.**

*Demonstrate mastery of the multiplication tables for numbers between 1 and 10 and of the corresponding division facts*

The corresponding pretest and posttest asked students to multiply or divide the following numbers:  $5 \times 8$  and  $32 \div 8$ . Of the 16 students who took the pretest, eight students or 50% of the population were able to answer the exercise successfully. Two

students, or 13% of the population, failed to record a response to the exercise at all. On the posttest, five of the students or 38% of the population answered the exercise correctly, and all of the students recorded an answer for the problem. I was unable to retest one of the students who correctly answered the problem on the pretest, and who may have successfully performed the exercise on the posttest, thereby increasing the statistics. I did notice that on the posttest, there were several students who correctly solved the multiplication fact, but failed to solve the division fact. There were also other simple mistakes made. One student miscounted the groupings used in the division problem, and another student multiplied instead of dividing. These mistakes are simple errors, but they do show some familiarity with the operations this standard was intended to teach.

Observations throughout the semester for this standard were not available because the students were beginning multiplication and division near the end of the term. The statistics for the posttest may have been positively affected by one of the students I was unable to retest, but there is no clear indication except that this student correctly answered the exercise on the pretest. One significant note for this standard and its corresponding problem on the tests is the number of students who successfully completed one or the other parts of the problem. This demonstrates that the standard may not be mastered, but that there is some instruction base present. Another difficult element on this exercise is the use of the algorithmic mathematical symbol for division,  $\div$ , to which students were never introduced. I noticed that some students added instead of dividing for this problem, which can be related to the close relationship between the two symbols for the operations,  $+$  and  $\div$ . This simple mix up only means that students were unfamiliar with the notation of this equation.

#### **Indiana Mathematical Standard 4.2.5.**

*Use a standard algorithm to multiply numbers up to 100 by numbers up to 10, using relevant properties of the number system*

The corresponding problem on the pre and posttests asked the students to multiply the following numbers,  $72 \times 5$  and  $43 \times 4$ . On the pretest, six of the 16, or 38% of the population, answered the problem correctly. Six of the students, or 38% of the population, failed to record a response for the exercise. This is not a surprising statistic to me, because I am under the impression that students are not very familiar with the multiplication process until the fourth grade, and the pretest was given before instruction could occur. It does go to show however, that students come into the classroom at different levels and with various experiences. On the posttest, five of the 13 students or 38% of the population were able to answer the problem correctly. However, only three students, or 23% of the population failed to answer the exercise at all. One of the students who answered the exercise correctly on the pretest was not retested, which may have affect the resulting statistics.

Once again, no classroom observations were made for this standard because of the sequence of mathematical instruction. Multiplication was started at the end of the semester, just prior to the end of the investigation, so an advanced concept such as this could not be expected to be mastered at this point. There were a couple of encouraging factors that showed up during the analysis process. One especially encouraging thing that I noticed is the fact that several of the students who offered no response on the pretest attempted the problem on the posttest. This is a positive to take away from this investigation because it shows progression towards the goal, and also serves as evidence of standards based mathematics education in the classroom.

#### **Indiana Mathematical Standard 4.2.6.**

*Use a standard algorithm to divide numbers up to 100 by numbers up to 10 without remainders, using relevant properties of the number sequence*

The corresponding problem on the pre and posttest asked students to divide the following numbers,  $54 \div 3$  and  $65 \div 5$ . Of the 16 students who took the pretest, none or zero percent of the population were able to complete the exercise successfully. There were also five students, or 31% of the population who did not record an answer for the exercise at all. Once again, this is not surprising because of the sequence of mathematical instruction and the lack of familiarity with the division algorithm. On the posttest, two students, or 15% of the population were able to answer the exercise successfully, and only four students or 31% of the population failed to answer the exercise at all.

Observations of this standard in the classroom did not occur during the course of the semester. As I have stated before, the division concept and algorithm were not introduced until the very end of the semester, so mastery during the course of this investigation was not a reasonable expectation. The success of a couple of the students however, demonstrates a standards based foundation and instructional purpose. Also encouraging, is the fact that a couple of the students were able to provide answers for half of the problem, but lacked sufficient practice and experience to complete the problem successfully. One simple factor may be the students' lack of familiarity with the algorithmic division sign,  $\div$ , as mentioned earlier.

#### **Indiana Mathematical Standard 4.2.7.**

*Understand the special properties of 0 and 1 in multiplication and division*

The corresponding pre and posttest exercise asked students to multiply or divide the following numbers,  $42 \times 1$ ,  $30 \times 0$ , and  $22 \div 1$ . This problem offered some encouraging results when analyzed. Eight of the 16 pretest participants or 50% of the population answered the problem correctly. In addition, only three students, or 19% of the population, failed to record a response to the exercise at all. The success on this problem on the pretest is surprising, because I am not sure what kind of exposure to these special cases students have prior to fourth grade. The posttest results were just as heartening, with nine students or 69% of the population, completing the exercise successfully and no students failing to respond to the exercise.

Observations of this standard were not recorded during my time in the classroom, but I am aware of some instruction on these rules that may have led to the high success rate of students on the posttest. Another interesting note about this particular standard is the fact that several of the struggles students had on the pretest were when there was a zero in the equation. This shows that some students have familiarity with the rule of one in multiplication and division, laying a foundation for instruction that is standards based and possibly occurred shortly after the end of this investigation. This is another example of standards instruction in the classroom that leads to mastery and follows the Indiana guidelines.

**Indiana Mathematical Standard 4.2.8.**

*Add and subtract simple fractions with different denominators, using objects or pictures*

The corresponding pre and posttest problem asked students to use a picture of a square divided into four equal parts to find  $\frac{3}{4} - \frac{1}{2}$ . Of the 16 students who took the pretest, no student was able to successfully answer the question for this exercise. On the

pretest as well, 12 students or 75% of the population made no attempt at the problem. The result was similar for the posttest, with no one able to complete the problem successfully, and eight students or 62% of the population failing to record an answer at all. I was also unable to observe any instance of this standard during my time in the classroom over the course of the semester. I observed a lesson involving fractions, but it was a simple introductory lesson with which all of the students struggled. It was meant as an exposure to the concept, which was slated to be taught later, so it did not have any bearing on this investigation. One encouraging thing about this standard is that several students made attempts on both the pre and posttest.

**Indiana Mathematical Standard 4.2.9.**

*Add and subtract decimals (to hundredths), using objects or pictures*

The corresponding pre and posttest question asked the students to add and subtract some problems that were visually demonstrated with coins. The first part asked students to add the quantity of four pennies, three dimes, and two quarters to the quantity of two pennies, four dimes, and one quarter. The second part asked students to subtract the quantity of one penny and four dimes from the quantity of three pennies and three quarters. The pretest statistics were very disheartening. Only two of the students or 13% of the population were able to complete the exercise successfully, but only one student or six percent of the population failed to record a response. A major issue on the pretest was not the ability to add or subtract the numbers, but rather the ability to count the money to add and subtract the correct numbers. This exercise was set up in accordance with the example given by the Indiana Academic Standards for this substandard. I did not foresee this problem when constructing the test. This is disappointing because it does not give a

true picture of whether the students were able to add and subtract decimals. On the posttest, six students or 46% of the population answered the problem correctly, but two students or 15% of the population failed to record an answer to the exercise.

Unfortunately no observational data were recorded for this standard. However, I did observe lessons on counting money during the semester of this investigation. This may have positively affected the statistics for the posttest, but I have no definite proof. An encouraging thing about the posttest is the fact that several students were able to complete either the addition or subtraction part, while missing the other. This demonstrates a definite progression during the semester, although the true focus on decimals seems to have been lost in the process.

**Indiana Mathematical Standard 4.2.10.**

*Use a standard algorithm to add and subtract decimals (to hundredths)*

The corresponding pre and posttest problem asked students to add or subtract the following decimals,  $.34 + .52$  and  $.45 - .21$ . Statistically, on the pretest only two of the 16 students or 13% answered the exercise correctly while eight students or 50% failed to record a response for the exercise. Those who did answer the pretest failed to use the decimals, which were a focus of the problem, but accomplished the addition and subtraction processes. On the posttest, nine students or 69% of the population answered the problem correctly, while no students failed to record a response for the exercises. The no response statistic may be misleading, because the three students I was not able to retest were three of the no response students on the pretest. This tints the statistics, but it also demonstrates that the other no response students from the pretest tried the problem, whether or not they were successful. On the posttest, like the pretest, all but one student

who successfully completed the problem failed to use decimals in the answer, and a couple of students were able to answer only half of the exercise. I was also unable to observe any instances in the classroom of the skills involved in this standard being taught. These results show that students are able to add and subtract, but as of the end of the semester had failed to master the use of decimals.

**Indiana Mathematical Standard 4.2.11.**

*Know and use strategies for estimating results of any whole-number computations*

The corresponding exercise on the pre and posttest asked students the following question: Your friend says  $45,256 + 7,235 = 5,895$ ; without solving, explain why you think the answer is right or wrong. On the pretest, five students or 31% of the population were able to complete the activity successfully while ten students, 63% of the population, did not record a response for the problem. Of the students who were able to successfully respond to the question, very little reasoning or explanations were given for the exercise. On the posttest, eight students or 62% answered the question correctly while four students, 31% of the population, failed to provide an answer for the problem. Although the explanations did remain weak, there were a couple of responses worth noting. One student explained why the answer was wrong because “45,256 is to [sic] big of a number.” By far the best response and explanation, came from a student who stated, “it is wrong because 45,256 is bigger than 5,895 so it has to be bigger.” These responses demonstrate that some critical thinking and estimating skills exist for some students.

I did make an observation during the course of the semester that demonstrates this standard. On October 12, 2002, I observed a lesson dealing with front-end and adjusted estimation that taught students estimation strategies. During the course of this lesson,



several students showed awareness and some mastery for front-end estimation, while adjusted estimation remained a difficult concept. These results show that this concept was taught and some strategies were given that would allow the students to master this standard. While no distinct evidence is present that students mastered this concept in the first semester, the foundation and skills were laid that could foster mastery during the second semester of the fourth grade.

**Indiana Mathematical Standard 4.2.12.**

*Use mental arithmetic to add or subtract numbers rounded to hundreds or thousands*

The corresponding exercise on the pre and posttest asked students: Do you think  $3,000 + 8,000$  is greater or less than 10,000? Explain why but do not solve the problem. On the pretest, five students, 31% percent of the population answered the problem correctly while ten students, 63% of the population, failed to respond to the exercise. Those who did respond to the exercise on the pretest offered very little explanation for the answer, and some solved it even though the problem directed them not to. On the posttest, six students or 46% of the population answered the question correctly while three students or 23% of the population failed to answer the question. Once again, explanations were either weak or nonexistent for all responses and some students solved the problem even though the problem stated not to.

In addition to the test data, I observed an instance of mental arithmetic instruction during the semester. On October 18, 2002, I observed direct instruction involving the use of mental math to add large and small numbers. The lesson was aimed at using rules for 5, 50, and 500 to solve addition problems. Several of the students involved in this

investigation mastered this skill, which demonstrates the emphasis on this standard during classroom instruction, following the state academic standards.

### **Problem-Solving Standard**

#### **Indiana Mathematical Standard 4.7 *Problem Solving*.**

The problem-solving standard is the second standard I examined in this investigation. There are ten substandards that are listed under this standard in the Indiana Academic Standards. These substandards are listed under three headings covering different aspects of problem solving. The headings are listed before each corresponding group of substandards to demonstrate correlation. Each substandard had a corresponding question on the pre and posttests. I also kept each substandard with me during mathematics instruction in the classroom to aid in my daily observations. Each substandard was evaluated individually for the population to gauge mastery and effectiveness, with the following results.

❖ *Students make decisions about how to approach problems and communicate their ideas.*

#### **Indiana Mathematical Standard 4.7.1.**

*Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns*

The corresponding pre and posttest question asked students to find a relationship between the addition of odd and even numbers. It suggested that students try adding different combinations and looking for patterns. On the pretest, no students were able to complete the exercise with any success, and 16 or 100% of the population failed to answer the exercise at all. The posttest had a similar result, with no students able to complete the problem successfully, and 12 or 92% of the population failing to answer the exercise at all. One student did record a response and made a very feeble attempt at

discovering a pattern, but effort and knowledge were not evident and the pattern was given up. In addition to the lack of statistical evidence, no observational data were collected for this standard either. This demonstrates that this aspect of problem-solving standards based instruction had not been taught by the end of the semester.

**Indiana Mathematical Standard 4.7.2.**

*Decide when and how to break a problem into simpler parts*

The corresponding problem on the pre and posttests asked students to use information from the previous question, and find what happens when an odd number is added to an even number. None of the students were able to complete the exercise correctly on the pretest, and 16 students or 100% of the population failed to respond to the problem at all. The posttest was slightly better with only nine students, 69% of the population, failing to answer, but no participant was able to answer the exercise correctly. One posttest response stated that “you get both things,” while another of those who did respond stated that “you mostly get an even number.” These attempts give some hope that this standard has some grounds in the minds of students, but clearly indicates that very little, if any, instruction had been given or mastered by the end of the semester. The lack of responses is not surprising given the fact that this problem somewhat relies on information from the previous problem, which no one answered.

I was able to observe to a minor degree an instance of instruction for this standard. On October 18, 2002, as part of a lesson on using mental math, instruction was given on how to break addition problems into simpler parts to aid mental computation. Students gave the impression of clear understanding and several students seemed to effectively use this strategy to aid their mental math mastery. These observational data tell me that some

foundation for this problem-solving standard exists, but no decisive evidence of mastery occurred during the semester.

❖ *Students use strategies, skills, and concepts in finding and communicating solutions to problems.*

**Indiana Mathematical Standard 4.7.3.**

*Apply strategies and results from simpler problems to solve more complex problems*

The corresponding problem on the pre and posttest asked students to use their work from the previous two problems to describe the result of the following problems without solving,  $332 + 45$  and  $450 + 28$ . Only one student, six percent of the population, was able to answer the problem correctly on the pretest, while 15 students or the other 94% failed to answer the problem at all. On the posttest, none of the students were able to complete the exercise correctly, and nine students, 69% of the population failed to respond to the problem at all. The student who responded correctly to the problem on the pretest, is one of the students I was unable to retest at the end of the semester. The lack of performance can somewhat be related to the lack of performance on the previous problems that may have assisted students. During the course of the semester I did not observe any instances of this standard being instructed. This lack of observational data and low performance demonstrates that students had not learned this standard by the end of the first semester.

**Indiana Mathematical Standard 4.7.4.**

*Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, tools, and models to solve problems, justify arguments, and make conjectures*

The corresponding question on the pre and posttest asked students to make a table or chart to help explain the work in the previous problems to another student. The lack of responses on the previous problems once again somewhat correlated to the statistics for this exercise. On the pretest, none of the students were able to complete the problem successfully because all 16, 100% of the population, failed to record any response at all. The results were identical for the posttest because no students completed the problem successfully and 13 students, 100% of the population, failed to record a response at all.

I did make an observation of this standard during the semester however. On December 3, 2002, I actually taught a lesson in which the use of a table to solve problems was demonstrated. Several practice problems were given for the lesson, and students completed them satisfactorily. This observation demonstrates that direct instruction of this standard was given, but student mastery remained very weak.

**Indiana Mathematical Standard 4.7.5.**

*Express solutions clearly and logically by using the appropriate mathematical terms and notation. Support solutions with evidence in both verbal and symbolic work*

The corresponding problem on the pre and posttests asked students to use their own words to explain the results of the following: The sum of an even and odd number, the sum of two odd numbers, and the sum of two even numbers. None of the participants were able to complete the problem correctly, and 15 students, 94% of the population, failed to record a response for the exercise at all. One student made an attempt at two of the questions, but the attempts consisted of one-word answers that did not demonstrate a logical understanding of the question. The posttest statistics were similar because no students were able to complete the exercise correctly, and 11 participants, 85% of the

population, failed to record a response at all. One of the students who responded on the posttest described the solutions with the same wording as the problem itself contained. The other student who made an attempt did not clearly express the solution, and the patterns found were incorrect. No observational data were collected during the course of the semester for this standard. The minimal attempts and lack of observation show that this standard was not specifically concentrated on during the time of this investigation.

**Indiana Mathematical Standard 4.7.6.**

*Recognize the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy*

The corresponding question on the pre and posttests asked students how accurate they should be when telling a friend the time of an appointment, to the nearest day, hour, minute, or second. On the pretest, one student or six percent of the population was able to answer the exercise successfully. Fourteen participants, 88% of the population, failed to record a response for the exercise on the pretest. The student who correctly answered the problem indicated that a person should be accurate to the hour and minute. This dual answer surprised me because I was expecting students to only answer with one of the choices, but this student made me realize that I was oversimplifying the problem a little. The student who attempted the problem but was unsuccessful answered that a person should be accurate to the nearest hour. This demonstrates a basic understanding of approximation, which was surprising for a student at the beginning of the semester. On the posttest, two students who comprised 15% of the population answered the exercise correctly, while 10 students, 77%, failed to respond to the problem at all. The student who missed the question on the pretest was one of the participants who was able to answer it correctly on the posttest. This demonstrates a progression in understanding and

mastery for this standard for at least one student. The other student who answered the question offered the same dual answer that the student on the pretest offered. The student who answered correctly on the pretest was one of the students I was unable to retest. I was also unable to observe instruction in the skills involved in this standard during the semester.

**Indiana Mathematical Standard 4.7.7.**

*Know and use appropriate methods for estimating results of whole-number computations*

The corresponding exercise on the pre and posttests asked the students if they would be surprised by a total of \$4.85 if they purchased 2 candy bars for \$.99 each. Two students, 13% of the population, answered the problem correctly on the pretest while the other 14 participants, 88%, failed to record a response. The two correct responses were simple yeses, that I thought about marking wrong because of a lack of explanation. Then I realized that the question was not worded to promote any depth of response, so I noted the answers and gave credit for the thinking that the students showed. On the posttest, 10 students who comprised 77% of the population were able to answer the problem correctly, while one student or eight percent failed to answer the question at all. These answers were simple yeses to the question, but the large increase in correct responses shows a marked progression in the understanding of estimation that this standard suggests.

I did not observe any instances of this standard in action in the classroom, but other work on estimation obviously affected the students' abilities to answer this problem correctly. Although direct instruction of the standard may not be present, standards-based education is still occurring in the classroom as a result of other lessons.

#### **Indiana Mathematical Standard 4.7.8.**

*Make precise calculations and check the validity of the results in the context of the problem*

The corresponding problem on the pre and posttests asked the students to determine how many buses with a capacity of 45 people would be needed to seat 100 people on a field trip. None of the students were able to answer the problem successfully on the pretest, and 14 participants, 88% percent of the population failed to record a response at all. The two responses that did occur on the pretest were quite unique. One student attempted the problem by subtracting 45 from 110, a logical first step in performing measurement division. This shows an effort, but a lack of follow through on the problem. The other response given was an answer of 5, which shows some thinking skills, but demonstrates a lack of checking the validity of the results. These deficiencies were not surprising for the pretest. On the posttest, two students, 15% of the population were able to answer the question correctly while five participants, 38%, failed to respond to the question at all. The correct responses did not contain any work or other signs of mathematical processing so I am unable to reach any conclusions about the students' progress toward understanding. Incorrect responses ranged from 2 buses or 4 buses to 55 buses. These responses also included no work or process evidence, so the only thing I can conclude is that these students failed to check the validity of their responses in the context of the problem.

Observational data for this standard were not collected, so there is little help from that perspective. The only conclusion I can draw is that students progressed throughout the semester in their calculation abilities, but more focus was needed on checking validity, as this standard delineates.



❖ *Students determine when a solution is complete and reasonable and move beyond a particular problem by generalizing to other situations.*

**Indiana Mathematical Standard 4.7.9.**

*Decide whether a solution is reasonable in the context of the original situation*

The corresponding question on the pre and posttests asked students if an answer of 2.93 on the previous question would surprise them, and to explain why or why not. On the pretest none of the students were able to complete the problem correctly because all 16 or 100% of the population failed to respond to the problem. On the posttest, none of the students were able to answer the exercise correctly, but only 10, 77% failed to answer the question at all. Two of the responses on the posttest were simple noes, with no explanation or demonstration of understanding of the problem. One of the responses was a correct yes, but there was no explanation or thinking evident which satisfied the standard.

There was one instance of observational data that I was able to collect. On December 3, 2002 I taught a lesson on problem solving and stressed the process of looking back and checking work in the context of Polya's four-step plan. All students involved in this study showed proficiency and understanding of this concept. Unfortunately, as can be seen by the statistics, the students were unable to effectively apply this on the corresponding test question. This is a demonstration of how instruction that is standards based can occur, but not necessarily affect the performance of students.

**Indiana Mathematical Standard 4.7.10.**

*Note the method of finding the solution and show a conceptual understanding of the method by solving similar problems*

The corresponding question on the pre and posttests asked students to try adding 4 odd numbers or 4 even numbers together and think about what the result might be. This

was intended to extend the earlier problem and help students solve a similar problem. On the pretest none of the students were able to complete the exercise successfully and 14, 88% of the population failed to respond at all. The two responses came from students who showed some work on the question, but did not draw any conclusions or generalize for other situations. None of the students were able to answer the question correctly on the posttest. All 13 of the students, 100%, failed to record any response. No observational data were collected for this standard during the semester. This demonstrates that not all standards or connections were necessarily approached during the semester that this investigation occurred. It also demonstrates the interrelation of the standards to each other because students were not able to answer previous questions about adding odd and even numbers, and subsequently could not answer or generalize on a similar problem.

## **Conclusions**

These data and analysis involved in this study made me examine a lot of things in relation to my future teaching and the education field in general. I designed this study to explore the application of the academic standards in the classroom. Mathematics is my subject of interest, so naturally I chose to examine the implementation of the mathematics standards. This study gave me the opportunity to look at how standards affect the mathematics education in an elementary school setting. Observing and documenting the chosen standards during this investigation gave me insight and experience that will enable me to be a more effective mathematics educator in my future. I now have a better understanding of the importance of the standards in classroom planning and student development. This investigation has provided me with an understanding of the standards framework and its applicability to the classroom. The standards are set forth to guide the development of students as well as provide a framework for a common education for all students at different levels. My experience in the teaching program at Ball State University focused on incorporating the standards into my education planning. This investigation made me realize that this preparation is very important because of the emphasis put on standards based education in American public schools. Having conducted this investigation, I now feel more accomplished as a future educator and excited to incorporate the standards in my future classroom.

### **Educational Implications**

For the educational world in general, the implications are broad. I think that this study has proven a couple of things that are of importance to all professionals in the education field. It is my belief that this investigation demonstrated the presence and

importance of standards in the classroom. Standards based education is the current trend in public education. The standards set forth by the Indiana Department of Education are very focused objectives for all students and teachers. These standards differ from the conceptually visionary principles and standards delineated by the NCTM. The NCTM principles and standards for curriculum are broad based guidelines for conceptual mathematics education. The Indiana Department of Education used these visionary standards to formulate the Indiana Academic Standards that are the backbone of education curriculum in the state of Indiana. This investigation demonstrates the presence of these academic standards in the classroom, whether or not directly instructed.

Another implication I think this investigation provides involves the standards correlation across the concepts and grade levels. It is my belief that several of the standards in this investigation were not mastered by the participants because of a lack of preparation and mastery of previous standards essential to success. In this investigation, I also observed that the standards are connected conceptually. This investigation demonstrates that the standards are related and are designed as a framework that continually builds upon itself. This means that all educators need to work to build mastery of standards at each level in order to promote success for their students in the future. This investigation was designed to give insight into the implementation of standards in mathematics education, and I feel that it has done so as well as provide insight into other aspects of the standards. The question was asked about the actual level of mastery and development of student skills according to the standards set forth by the Indiana Department of Education. The data collected and analyzed gave a glimpse of this mastery and development, which serves to help all educators further understand the

standards. After completing this study, I now have a better insight and understanding of what secretary Ravitch asserted in her book. Having standards may not be the best possible solution, but they do provide a framework for what educators should be teaching and what students should be learning. I may not completely agree with using standards as the educational foundation, but a standards based foundation, in my opinion, is the best possible alternative to this point. This study serves as a baseline of data that demonstrates the impact of standards in the classroom, the mastery of the skills by one fourth grade class, and also explores the design and emphasis of standards based education in the public school classroom.

### **Extensions/Questions**

This investigation was completed effectively, but as with any investigation, improvements and questions always follow the completion of the project. If I were to undertake this investigation again, there are several things that I would do differently. This investigation was conducted in conjunction with another exciting experience for me. As well as gathering statistical and observational data, I was involved in the every day workings of the classroom. Along with the responsibilities of this investigation, I was also responsible for daily classroom operations and procedures. While this afforded me the opportunity to observe the classroom, it did add more stress and responsibility to the experience. If I were to conduct this investigation again, I would make the study the only responsibility in order to get the most out of the project. Another change I would make is to lengthen the investigation. The one semester provided sufficient information, but in order to gather the most comprehensive data about the mastery of standards I think it would be more effective to gather data for a full year. Despite the success of this

investigation, it is my feeling that these improvements would make the study even more complete. Improvements are always a possibility and this study could have used some, but I think it was effective nonetheless.

Along with the improvements that could have been made, there was also another question raised at the end of this investigation. This study was conducted in a public elementary school in an urban setting. The information collected is from one main demographic group and area. This brings up a question of what data would have been collected in a different environment. This investigation yielded information from this one distinct population, and the pattern or results may not be similar with a different population. This does not take anything away from this investigation, but it does offer a question that could spawn yet another investigation similar to this one.

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Appendix A:  
**Informed Consent Form**



Aug 26, 2002

Dear 4<sup>th</sup> Grade Parent:

I would like to begin this year by introducing myself and my role in your child's classroom. My name is Derrick Lane and I am a senior Elementary Education student from Ball State University. I am participating in your child's classroom as part of the Urban Semester program during this, the fall semester of 2002. I look forward to cooperating with Ms. Edwards and you, the parents, to make this semester a successful and engaging experience for your student and myself.

This semester, with the cooperation of Ms. Edwards, I am engaging in a classroom research study as part of my education at Ball State University. The research study entitled "Standard Education: An Examination of 4<sup>th</sup> Graders' Computational and Problem-Solving Skills" is examining the level of mastery of the computational and problem solving academic standards as set forth by the Indiana Department of Education. Students will be asked to complete a pre-study survey as well as a post-study survey to measure their level of mastery of these standards. I will also be observing your student on a daily basis and noting instances of mastery of these standards. These activities will take place during the regular school day and will not require any additional work.

Students will provide only their first names or first names and the first letter of their last name for identification purposes on the surveys and during observations. All information will be kept completely confidential. Your child's participation in this study is completely voluntary and does not affect your child's records or grades in any manner. You or your child are free to withdraw and discontinue your child's participation at any time without prejudice from me.

Attached you will find a consent form that is required by the Institutional Review Board of Ball State University. Please sign this form and have your child return it as soon as possible. Please feel free to contact any of the investigators with any questions you have before signing the consent forms and beginning the study, and any time during the study.

Once again, I look forward to working with your student and Ms. Edwards this semester. Lets make this a great semester.

Derrick Lane

Derrick Lane

Ms. Edwards

Ms. Edwards

## **Standard Education: An Examination of 4<sup>th</sup> Graders' Computational and Problem-Solving Skills**

The purpose of this research study is to evaluate the level of 4<sup>th</sup> graders' computational and problem-solving skills at the beginning of the first semester, the progression of these skills throughout the semester, and the level of skill at the conclusion of the semester, according to the Indiana Academic Standards for Mathematics. The Indiana Academic Standards for Mathematics are the guidelines set up to develop students in educational settings. Testing will occur over two days, one at the beginning of the semester and one at the end of the semester. Observation will occur throughout the duration of the semester.

As a subject, your student will be asked to complete two tests/surveys evaluating his or her computational and problem-solving skills based on the Indiana Academic Standards for Math Education of 4<sup>th</sup> graders. These tests/surveys will be the same both times they are given. They consist of free response questions based on the standards and sub standards laid out by the Indiana Board of Education. During the semester, your student will be observed in everyday classroom activities and notes will be taken regarding progression according to the standards. At the end of the semester, the tests and observation notes will be evaluated and written up.

There are no risks associated with this research study. The benefits of this research are important. First, the students will be evaluated and this knowledge will help the classroom teacher to better educate them according to the standards once the results are reported. The second is that this research will give a better understanding of the application of the standards in the classroom so that future potential educators will be prepared to educate properly and effectively.

Participation in this research is completely voluntary and will not affect the student's grades or records. You are free to remove your student from the study at any time for any reason without any penalty or prejudice from the investigator. All records and results will be kept confidential. Students will only be identified on a first name basis, unless there are several with the same names, in which case the first letter of the last name will be used as well. All records will be kept sealed and locked away when not in the possession of the researcher to prevent breaches of confidentiality.

For your student's rights as a research subject, the following persons may be contacted: Ms. Sandra Smith, Coordinator of Research Compliance, Office of Academic Research and Sponsored Programs, Ball State University, Muncie, IN 47306, (765) 285-1600.

\*\*\*\*\*

I give my consent for my child, \_\_\_\_\_, to participate in this research study entitled "**Standard Education: An Examination of 4<sup>th</sup> Graders' Computational and Problem-Solving Skills**." I have read the description of the study and understand what it says. Any questions I had were answered to my satisfaction. I have read this description of the study and give my consent for my child named above to participate. I understand that I will receive a copy of this consent form to keep for future reference.

\_\_\_\_\_  
Parent's Signature

\_\_\_\_\_  
Date

This study has been fully explained to me and I understand what I have to do. I, \_\_\_\_\_, agree to participate in this project entitled, "**Standard Education: An Examination of 4<sup>th</sup> Graders' Computational and Problem-Solving Skills**."

\_\_\_\_\_  
Child's Assent Line

\_\_\_\_\_  
Date

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**Appendix B:**  
**Pre and Posttest**

## Survey

1. Solve the following addition and subtraction problems.

$$45,329 + 6,984 =$$

$$36,296 + 12,075 =$$

2. A woman makes 5 bracelets. Each bracelet has 4 beads. Find the total number of beads the woman used.

3. If you have 20 cookies, how many would each student get if you divided it evenly among 5 students?

4. Multiply or divide the following numbers.

$$5 \times 8 =$$

$$32 \div 8 =$$

5. Multiply the following numbers.

$$72 \times 5 =$$

$$43 \times 4 =$$

6. Divide the following numbers.

$$54 \div 3 =$$

$$65 \div 5 =$$

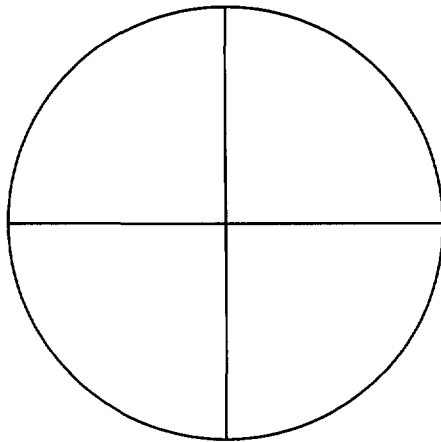
7. Multiply or divide the following numbers.

$42 \times 1 =$

$30 \times 0 =$

$22 \div 1 =$

8. Use this picture of a circle divided into fourths to find  $\frac{3}{4} - \frac{1}{2} =$



9. Add the following.



+



Subtract the following.



---



10. Add or Subtract the following decimals.

$$.34 + .52 =$$

$$.45 - .21 =$$

11. Your friend says  $45,256 + 7,235 = 5,895$ . Without solving, explain why you think the answer is right or wrong.

12. Do you think  $3,000 + 8,000$  is greater or less than 10,000? Explain why but do not solve the problem.

13. Find a relationship between the addition of odd and even numbers. Try adding different combinations and look for patterns.

14. From the previous question, find what happens when you add an odd number to an even number.

15. Using your work from #13 and #14, describe what the result will be of the following problems. (**DO NOT SOLVE**)

$$332 + 45 =$$

$$450 + 28 =$$

16. Make a table or chart to help you explain your work in #13 and #14 to another student.

17. In your own words, explain the results of the following:

Sum of an even number and an odd number

Sum of two odd numbers

Sum of two even numbers

18. If you are telling a friend the time of an appointment, how accurate should you be: to the nearest day, hour, minute, or second?

19. You buy 2 candy bars for \$.99 each. The cashier says your total is \$4.85. Does that total surprise you?



20. The buses for your field trip hold 45 people each. How many buses will be needed to seat 110 people?

21. Would an answer of 2.93 surprise you in the previous question? Why or why not?

22. Now try adding 4 odd numbers or 4 even numbers together. What do you think the results will be?

Appendix C:  
**Data Collection Sheet**

Student Name	STANDARD 4																					
	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	2.12	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	7.10
Student 1																						
Student 2																						
Student 3																						
Student 4																						
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Student 29																						
Student 30																						
COMMENTS																						

Appendix D  
**Indiana Department of Education**  
**Academic Standards for Mathematics**  
**Standard 2: Computation**  
**Standard 7: Problem Solving**



## Standard 2

# Computation

*Students solve problems involving addition, subtraction, multiplication, and division of whole numbers and understand the relationships among these operations. They extend their use and understanding of whole numbers to the addition and subtraction of simple fractions and decimals.*

- 4.2.1 Understand and use standard algorithms\* for addition and subtraction.

Example:  $45,329 + 6,984 = ?$ ,  $36,296 - 12,075 = ?$

- 4.2.2 Represent as multiplication any situation involving repeated addition.

Example: Each of the 20 students in your physical education class has 3 tennis balls. Find the total number of tennis balls in the class.

- 4.2.3 Represent as division any situation involving the sharing of objects or the number of groups of shared objects.

Example: Divide 12 cookies equally among 4 students. Divide 12 cookies equally so that each person gets 4 cookies. Compare your answers and methods.

- 4.2.4 Demonstrate mastery of the multiplication tables for numbers between 1 and 10 and of the corresponding division facts.

Example: Know the answers to  $9 \times 4$  and  $36 \div 4$ .

- 4.2.5 Use a standard algorithm to multiply numbers up to 100 by numbers up to 10, using relevant properties of the number system.

Example:  $67 \times 3 = ?$

- 4.2.6 Use a standard algorithm to divide numbers up to 100 by numbers up to 10 without remainders, using relevant properties of the number system.

Example:  $69 \div 3 = ?$

- 4.2.7 Understand the special properties of 0 and 1 in multiplication and division.

Example: Know that  $73 \times 0 = 0$  and that  $42 \div 1 = 42$ .

- 4.2.8 Add and subtract simple fractions with different denominators, using objects or pictures.

Example: Use a picture of a circle divided into 6 equal pieces to find  $\frac{5}{6} - \frac{1}{3}$ .

- 4.2.9 Add and subtract decimals (to hundredths), using objects or pictures.

Example: Use coins to help you find  $\$0.43 - \$0.29$ .

- 4.2.10 Use a standard algorithm to add and subtract decimals (to hundredths).

Example:  $0.74 + 0.80 = ?$

- 4.2.11 Know and use strategies for estimating results of any whole-number computations.

Example: Your friend says that  $45,329 + 6,984 = 5,213$ . Without solving, explain why you think the answer is wrong.

- 4.2.12 Use mental arithmetic to add or subtract numbers rounded to hundreds or thousands.

Example: Add 3,000 to 8,000 without using pencil and paper.

\* algorithm: a step-by-step procedure for solving a problem.



# Problem Solving

*Students make decisions about how to approach problems and communicate their ideas.*

- 4.7.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

**Example:** Solve the problem: "Find a relationship between the number of faces, edges, and vertices of a solid shape with flat surfaces." Try two or three shapes and look for patterns.

- 4.7.2 Decide when and how to break a problem into simpler parts.

**Example:** In the first example, find what happens to cubes and rectangular solids.

*Students use strategies, skills, and concepts in finding and communicating solutions to problems.*

- 4.7.3 Apply strategies and results from simpler problems to solve more complex problems.

**Example:** In the first example, use your method for cubes and rectangular solids to find what happens to other prisms and to pyramids.

- 4.7.4 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, tools, and models to solve problems, justify arguments, and make conjectures.

**Example:** In the first example, make a table to help you explain your results to another student.

- 4.7.5 Express solutions clearly and logically by using the appropriate mathematical terms and notation. Support solutions with evidence in both verbal and symbolic work.

**Example:** In the first example, explain what happens with all the shapes that you tried.

- 4.7.6 Recognize the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

**Example:** You are telling a friend the time of a TV program. How accurate should you be: to the nearest day, hour, minute, or second?

- 4.7.7 Know and use appropriate methods for estimating results of whole-number computations.

**Example:** You buy 2 CDs for \$15.95 each. The cashier tells you that will be \$49.90. Does that surprise you?

- 4.7.8 Make precise calculations and check the validity of the results in the context of the problem.

**Example:** The buses you use for a school trip hold 55 people each. How many buses will you need to seat 180 people?

*Students determine when a solution is complete and reasonable and move beyond a particular problem by generalizing to other situations.*

- 4.7.9 Decide whether a solution is reasonable in the context of the original situation.

**Example:** In the last example, would an answer of 3.27 surprise you?

- 4.7.10 Note the method of finding the solution and show a conceptual understanding of the method by solving similar problems.

**Example:** Change the first example so that you look at shapes with curved surfaces.